

What is claimed is:

1 1. A communication node comprising:
2 an optical signal transceiver having at least one optical
3 signal transmitting device and at least one optical signal
4 receiving device to transmit and receive an optical signal to and
5 from an opposite communication node;
6 at least one optical signal transmitting communication line
7 to transmit an optical signal to said opposite communication node;
8 at least one optical signal receiving communication line
9 to receive an optical signal from said opposite communication
10 node; and
11 a switching device being connected to said optical signal
12 transmitting device and to said optical signal receiving device
13 to transmit, when no failure has occurred in said optical signal
14 transmitting communication line and in said optical signal
15 receiving communication line, an optical signal fed from said
16 optical signal transmitting device to said optical signal
17 transmitting communication line and to transmit an optical signal
18 fed from said optical signal receiving communication line to said
19 optical signal receiving device, which does switching, when a
20 failure has occurred in said optical signal transmitting
21 communication line, so that said optical signal fed from said
22 optical signal transmitting device is transmitted to said optical
23 signal receiving communication line and which does switching,
24 when a failure has occurred in said optical signal receiving
25 communication line, so that said optical signal to be fed to said
26 optical signal receiving device is received from said optical
27 signal transmitting communication line.

1 2. The communication node according to Claim 1, wherein
2 wavelengths of optical signals transmitted from all said optical
3 signal transmitting devices being placed in said optical signal
4 transceiver are different from one another and from wavelengths
5 of optical signals transmitted from said opposite communication
6 node.

1 3. The communication node according to Claim 1, wherein said
2 switching device includes an optical switch that enables an
3 optical signal to be transmitted in bidirectional directions.

1 4. A communication node comprising:
2 a plurality of optical signal transceivers each having at
3 least one optical signal transmitting device and at least one
4 optical signal receiving device, which transmit and receive an
5 optical signal to and from an opposite communication node;
6 a plurality of optical signal communication lines to
7 transmit and receive an optical signal between each of said
8 optical signal transceivers and said opposite communication node;
9 and
10 a switching device being connected to said optical signal
11 transmitting device and to said optical signal receiving device,
12 which does switching, when a failure has occurred in any of said
13 plurality of said optical signal communication line, so that an
14 optical signal that had been transmitted through said optical
15 signal communication line is transmitted in a multiplexed manner
16 through any other optical signal communication line.

1 5. The communication node according to Claim 4, wherein a

2 wavelength of an optical signal that had been transmitted through
3 an optical signal communication line in which a failure occurred
4 is different from a wavelength of an optical signal that is
5 transmitted through an optical signal communication line in which
6 said optical signal is transmitted in a multiplexed manner when
7 a failure occurs in said optical signal communication line.

1 6. The communication node according to Claim 4, wherein said
2 switching device includes an optical switch that enables an
3 optical signal to be transmitted in bidirectional directions.

1 7. A communication node being used in a ring-type network in
2 which a plurality of said communication nodes is connected,
3 comprising:

4 an optical signal transceiver having at least one optical
5 signal transmitting device and at least one optical signal
6 receiving device to receive an optical signal from one adjacent
7 communication node and to transmit said optical signal to an other
8 adjacent communication node; and

9 a switching device being connected to one optical signal
10 communication line connected to said one adjacent communication
11 node, to an other optical signal communication line connected to
12 said other adjacent communication node, to said optical signal
13 transmitting device and to said optical signal receiving device,
14 which receives, when no failure has occurred in said one optical
15 signal communication line and in said other optical signal
16 communication line, an optical signal sent from said one adjacent
17 communication node from said one optical signal communication
18 line and transmits it to said optical signal receiving device and

19 transmits an optical signal to be transferred from said optical
20 signal transmitting device to said other adjacent communication
21 node to said other optical signal communication line and relays
22 an optical signal, when an optical signal fed from a communication
23 node other than said one adjacent communication node making up
24 said ring-type network is input from said other optical signal
25 communication line to transfer it to said one optical signal
26 communication line and which does switching, when the failure has
27 occurred in said one optical signal communication line, so that
28 said optical signal fed from said one adjacent communication node
29 is received from said other optical signal communication line and
30 is transmitted to said optical signal receiving device and does
31 switching, when the failure has occurred in said other optical
32 signal communication line, so that said optical signal to be
33 transferred from said optical signal transmitting device to said
34 other adjacent communication node is transmitted to said one
35 optical signal communication line.

1 8. The communication node according to Claim 7, wherein
2 wavelengths of optical signals transmitted by all communication
3 nodes making up said ring-type network are different from one
4 another.

1 9. The communication node according to Claim 7, wherein said
2 switching device includes an optical switch that enables an
3 optical signal to be transmitted in bidirectional directions.

1 10. A communication node being used in a ring-type network in
2 which a plurality of communication nodes is connected,

3 comprising:

4 an optical signal transceiver having a plurality of optical
5 signal transmitting devices to transmit an optical signal to an
6 adjacent communication node and a plurality of optical signal
7 receiving devices to receive an optical signal from said adjacent
8 communication node and to transmit and receive optical signals
9 to and from both of said adjacent communication node;

10 an optical signal transmitting communication line to
11 transmit an optical signal to said adjacent communication node;

12 an optical signal receiving communication line to receive
13 an optical signal from said adjacent communication node;

14 a switching device being connected to said optical signal
15 transmitting device and to said optical signal receiving device,
16 which transmits, when no failure has occurred in said optical
17 signal transmitting communication line and in said optical signal
18 receiving communication line, an optical signal to be transferred
19 from said optical signal transmitting device to said adjacent
20 communication node to said optical signal transmitting
21 communication line and receives an optical signal sent from said
22 adjacent communication node from said optical signal receiving
23 communication line and transmits it to said optical signal
24 receiving device and which does switching, when a failure has
25 occurred in said optical signal transmitting communication line,
26 so that an optical signal that had been transmitted from said
27 optical signal transmitting device to said optical signal
28 transmitting communication line is transmitted to said optical
29 signal receiving communication line being connected similarly to
30 said adjacent communication node to which said optical signal
31 transmitting communication line had been connected and does

32 switching, when a failure has occurred in said optical signal
33 receiving communication line, so that an optical signal that had
34 been received from said optical signal receiving communication
35 line and had been transmitted to said optical signal receiving
36 device is received from an optical signal transmitting
37 communication line being connected similarly to said adjacent
38 communication node to which said optical signal receiving
39 communication line had been connected.

1 11. The communication node according to Claim 10, wherein
2 wavelengths of optical signals to be transmitted from said optical
3 signal transmitting device to said adjacent communication node
4 are different from those of optical signals fed from said adjacent
5 communication node.

1 12. The communication node according to Claim 10, wherein said
2 switching device includes an optical switch that enables an
3 optical signal to be transmitted in bidirectional directions.

1 13. A switching device being connected to an optical signal
2 transceiver comprising at least one optical signal transmitting
3 device and at least one optical signal receiving device to
4 transmit and receive an optical signal to and from an opposite
5 communication node and making up a communication node with said
6 optical signal transceiver,
7 said switching device configured to be connected to at least
8 one piece of an optical signal transmitting communication line
9 to transmit an optical signal to said opposite communication node,
10 at least one piece of an optical signal receiving communication

11 line to receive an optical signal from said opposite communication
12 node, said optical signal transmitting device and said optical
13 signal receiving device; and

14 wherein, when no failure has occurred in said optical signal
15 transmitting communication line and in said optical signal
16 receiving communication line, an optical signal fed from said
17 optical signal transmitting device is transmitted to said optical
18 signal transmitting communication line and an optical signal fed
19 from said optical signal receiving communication line is
20 transmitted to said optical signal receiving device and wherein,
21 when a failure has occurred in said optical signal transmitting
22 communication line, switching is done so that said optical signal
23 fed from said optical signal transmitting device is transmitted
24 to said optical signal receiving communication line and, when a
25 failure has occurred in said optical signal receiving
26 communication line, switching is done so that said optical signal
27 to be fed to said optical signal receiving device is received from
28 said optical signal transmitting communication line.

1 14. The switching device according to Claim 13, wherein
2 wavelengths of optical signals fed from all of said optical signal
3 transmitting devices being placed in said optical signal
4 transceiver are different from one another and from those of
5 optical signals transmitted from said opposite communication
6 node.

1 15. The switching device according to Claim 13, further
2 comprising an optical switch that enables an optical signal to
3 be transmitted in bidirectional directions.

1 16. A switching device being connected to a plurality of optical
2 signal transceivers each having at least one optical signal
3 transmitting device and at least one optical signal receiving
4 device to transmit and receive an optical signal to and from an
5 opposite communication node and making up a communication node
6 with said plurality of optical signal transceivers,

7 said switching device configured to be connected to a
8 plurality of optical signal communication lines to transmit and
9 receive an optical signal between said optical signal
10 transmitting device and said opposite communication node, each
11 said optical signal transmitting device, and each said optical
12 signal receiving device,

13 wherein switching is done, when a failure occurs in any of
14 said optical signal communication lines, so that an optical signal
15 that had been transmitted through said optical signal
16 communication line in which said failure has occurred is
17 transmitted in a multiplexed manner through any other optical
18 signal communication lines.

1 17. The switching device according to Claim 16, wherein
2 wavelengths of optical signals that had been transmitted through
3 an optical signal communication line in which a failure has
4 occurred are different from those of optical signals that are
5 transmitted through an optical signal communication line in which
6 said optical signals are transmitted in a multiplexing manner when
7 said failure has occurred in said optical signal communication
8 line.

1 18. The switching device according to Claim 16, further

2 comprising an optical switch that enables an optical signal to
3 be transmitted in bidirectional directions.

1 19. A switching device being connected to an optical signal
2 transceiver having at least one optical signal transmitting
3 device and at least one optical signal receiving device and
4 receiving an optical signal from one adjacent communication node
5 and transmitting an optical signal to an other adjacent
6 communication node and making up a communication node of a
7 ring-type network, said switching device configured to be
8 connected one optical signal communication line connected to said
9 one adjacent communication node, to an other optical signal
10 communication line connected to said other adjacent communication
11 node, to said optical signal transmitting device and to said
12 optical signal receiving device,

13 wherein, when no failure has occurred in said one optical
14 signal communication line and in said other optical signal
15 communication line, an optical signal fed from said one adjacent
16 communication node is received from said one optical signal
17 communication line and is transmitted to said optical signal
18 receiving device and an optical signal to be transferred from said
19 optical signal transmitting device to said other adjacent
20 communication node is transmitted to said other optical signal
21 communication line and, when an optical signal fed from a
22 communication node other than said one adjacent communication
23 node making up said ring-type network is input from said adjacent
24 optical signal communication line, said optical signal is relayed
25 to transfer it to said one optical signal communication line and
26 switching is done, when a failure occurs in said one optical signal

27 communication line, so that said optical signal fed from said one
28 adjacent communication node is received through said other
29 optical signal communication line and is transmitted to said
30 optical signal receiving device and, when a failure has occurred
31 in said other optical signal communication line, an optical signal
32 to be transferred from said optical signal transmitting device
33 to said other adjacent communication node is transmitted to said
34 one optical signal communication line.

1 20. The switching device according to Claim 19, wherein
2 wavelengths of optical signals to be transmitted by all
3 communication nodes making up said ring-type network are
4 different from one another.

1 21. The switching device according to Claim 19, further
2 comprising an optical switch that enables an optical signal to
3 be transmitted in bidirectional directions.

1 22. The switching device being connected to an optical signal
2 transceiver having a plurality of optical signal transmitting
3 devices to transmit an optical signal to adjacent communication
4 nodes and a plurality of optical signal receiving devices to
5 receive an optical signal from said adjacent communication nodes
6 and to transmit and receive an optical signal to and from both
7 of said adjacent communication nodes and making up a communication
8 node of a ring-type network,
9 said switching device configured to be connected to an
10 optical signal transmitting communication line to transmit an

11 optical signal to said adjacent communication node, an optical
12 signal receiving communication line to receive an optical signal
13 from said adjacent communication node, said plurality of said
14 optical signal transmitting devices and said plurality of said
15 optical signal receiving devices,

16 wherein no failure has occurred in said optical signal
17 transmitting communication line and in said optical signal
18 receiving communication line, an optical signal to be transferred
19 from said optical signal transmitting device to said adjacent
20 communication node is transmitted to said optical signal
21 transmitting communication line and an optical signal fed from
22 said adjacent communication node is received from said optical
23 signal receiving communication line and is transmitted to said
24 optical signal receiving device and, when a failure has occurred
25 in said optical signal transmitting communication line, switching
26 is done so that an optical signal that had been transmitted from
27 said optical signal transmitting device to said optical signal
28 transmitting communication line is transmitted to an optical
29 signal receiving communication line being connected similarly to
30 said adjacent communication node to which said optical signal
31 transmitting communication line had been connected and when a
32 failure has occurred in said optical signal receiving
33 communication line, switching is done so that an optical signal
34 that had been received from said optical signal receiving
35 communication line and transmitted to said optical signal
36 receiving device is received from an optical signal transmitting
37 communication line being connected similarly to said adjacent
38 communication node to which said optical signal receiving
39 communication line had been connected.

1 23. The switching device according to Claim 22, wherein
2 wavelengths of optical signals to be transmitted from said optical
3 signal transmitting device to said adjacent communication node
4 are different from those of optical signals fed from said adjacent
5 communication node.

1 24. The switching device according to Claim 22, further
2 comprising an optical switch that enables an optical signal to
3 be transmitted in bidirectional directions.

1 25. A switching device for transmitting a plurality of external
2 optical signals through a plurality of optical signal
3 communication lines, comprising:

4 a plurality of optical multiplexing and demultiplexing
5 devices each being placed so as to correspond to said optical
6 signal communication line and having a plurality of first input
7 and output ports and one second input and output ports, which
8 allows optical signals being different from one another to be
9 transmitted between each of said first input and output ports and
10 said second input and output ports and has said second input and
11 output ports be connected to an optical signal communication line
12 being corresponded to said optical multiplexing and
13 demultiplexing device; and

14 a plurality of optical switches being placed so as to
15 correspond to said external optical signal, which allows an
16 external optical signal being corresponding to each of said
17 optical switches to be input to said first input and output port
18 of said optical multiplexing and demultiplexing device when no
19 failure has occurred in an optical signal communication line

20 corresponding to a specified optical multiplexing and
21 demultiplexing device and which does switching, when a failure
22 has occurred in said optical signal communication line, so that
23 said external optical signal is input to a first input and output
24 port of an other multiplexing and demultiplexing device.

1 26. The switching device according to Claim 25, wherein a
2 plurality of said first input and output ports of said plurality
3 of said optical multiplexing and demultiplexing devices allow
4 optical signal having wavelengths being different from one
5 another to be transmitted.

1 27. A switching device for transmitting a plurality of external
2 optical signals through a plurality of optical signal
3 communication lines comprising:
4 a plurality of first optical multiplexing and
5 demultiplexing devices each being placed so as to correspond to
6 said optical signal communication line and having a plurality of
7 first input and output ports and one second input and output ports,
8 which allows optical signals being different from one another to
9 be transmitted between each of said first input and output ports
10 and said second input and output ports and has each of said second
11 input and output ports be connected to an optical signal
12 communication line being corresponded to each of said optical
13 multiplexing and demultiplexing devices;
14 a plurality of second optical multiplexing and
15 demultiplexing devices each having a plurality of third input and
16 output ports and one fourth input and output port, which allows
17 optical signals being different from one another to be transmitted

18 between each of said third input and output ports and said fourth
19 input and output ports, each of said third input and output ports
20 being connected to each of a plurality of external optical signals
21 input and output ports being different from one another; and
22 an optical switch being placed so as to correspond to each
23 of said second optical multiplexing and demultiplexing devices,
24 which has a fourth input and output port of a second optical
25 multiplexing and demultiplexing device being corresponded to said
26 optical switch be connected to a first input and output port of
27 said first optical multiplexing and demultiplexing device when
28 no failure has occurred in an optical signal communication line
29 corresponding to a specified first optical multiplexing and
30 demultiplexing device and does switching so that a fourth input
31 and output port of said second optical multiplexing and
32 demultiplexing device is connected to a first input and output
33 port of other first optical multiplexing and demultiplexing
34 device when a failure has occurred in said optical signal
35 communication line.

1 28. The switching device according to Claim 27, wherein said
2 plurality of said first input and output ports of said first
3 optical multiplexing and demultiplexing device allows optical
4 signals having wavelengths being different from one another to
5 be transmitted and a plurality of said third input and output ports
6 of said second optical multiplexing and demultiplexing device
7 allows optical signals having wavelengths being different from
8 one another to be transmitted.

1 29. A switching device being connected between two optical

2 signal communication lines making up a ring-type network for
3 transmitting an external optical signal through said ring-type
4 network, comprising:

5 two optical multiplexing and demultiplexing devices each
6 being placed so as to correspond to each of said optical signal
7 communication lines and having a plurality of first input and
8 output ports and one second input and output port, which allows
9 optical signals being different from one another to be transmitted
10 between each of said first input and output port and said second
11 input and output port and has an optical signal communication line
12 corresponding to each of said optical multiplexing and
13 demultiplexing devices be connected to said second input and
14 output port and has part of said first input and output ports be
15 connected to one another; and

16 a plurality of optical switches each being placed so as to
17 correspond to said external optical signal, which has, when no
18 failure has occurred in an optical signal communication line being
19 connected to an optical multiplexing and demultiplexing device
20 corresponding to a specified optical signal communication line,
21 an external optical signal being corresponded to each of said
22 optical switches be input to a first input and output port of each
23 of said optical multiplexing and demultiplexing devices and does
24 switching, when a failure has occurred in said optical signal
25 communication line, so that said external optical signal is input
26 to a first input and output port of each of said optical
27 multiplexing and demultiplexing devices corresponding to an other
28 one optical signal communication line.

1 30. The switching device according to Claim 29, wherein a

2 plurality of said first input and output ports of said plurality
3 of said optical multiplexing and demultiplexing devices allow
4 optical signal having wavelengths being different from one
5 another to be transmitted.

1 31. A switching device for transmitting an external optical
2 signal through a ring-type network in which a plurality of optical
3 signal communication lines are connected between adjacent
4 communication nodes, comprising:

5 a plurality of optical multiplexing and demultiplexing
6 devices each being placed so as to correspond to each of said
7 optical signal communication lines and having a plurality of first
8 input and output ports and one second input and output ports, which
9 allows optical signals being different from one another to be
10 transmitted between each of said first input and output ports and
11 said second input and output ports and has an optical signal
12 communication line corresponding to each of said optical
13 multiplexing and demultiplexing devices be connected to said
14 second input and output port; and

15 a plurality of optical switches each being placed so as to
16 correspond to said external optical signal, which has, when no
17 failure has occurred in an optical signal communication line
18 corresponding to a specified optical multiplexing and
19 demultiplexing device, an external optical signal corresponding
20 to each of said optical switches be connected to a first input
21 and output port of each of said optical multiplexing and
22 demultiplexing devices and does switching, when a failure has
23 occurred in said optical signal communication line, so that said
24 external optical signal be input to a first input and output port

25 of other optical multiplexing and demultiplexing devices.

1 32. The switching device according to Claim 31, wherein a
2 plurality of said first input and output ports of said plurality
3 of said optical multiplexing and demultiplexing devices allow
4 optical signal having wavelengths being different from one
5 another to be transmitted.